

ANDREW PARKINSON

THINGS MAY APPEAR BLACK AND WHITE, BUT THE LIVES OF BADGERS ARE REALLY RATHER COLOURFUL, AS RESEARCHER **HANNAH DUGDALE** HAS BEEN FINDING OUT.

The private lives of
BADGERS

You might be mistaken in thinking that we know all there is to know about badgers.

Although the European badger has been the focus of much research, remarkably little is actually known about certain aspects of its life, in particular its mating system and social structure. This is primarily a result of the secretive nature of the species; it's tricky to study a nocturnal animal that mainly lives underground.

A sneaky peek

In simplistic terms, the concept of a 'mating system' deals with two questions: *Who breeds?* and *Who do they breed with?* Examples of mating

relationships with confidence and to piece together the jigsaw puzzle of genetic relationships within and between social groups.

The Wytham project

The Wildlife Conservation Research Unit (WildCRU) at the University of Oxford, led by David Macdonald, set out to investigate some of the questions by initiating a detailed study of the badger population of Wytham Woods in 1987. Since then, nearly every badger born into the Wytham population has been individually identified and monitored. This has resulted in one of the largest datasets concerning a medium sized carnivore in the world. From 1987 to 2005, 735

"USING ONLY A FEW HAIRS FROM EACH WYTHAM BADGER I WAS ABLE TO 'GENETICALLY FINGERPRINT' THEM"

systems include monogamy, where individuals form faithful pairs; polygyny, where single males mate with several females; polyandry, where single females breed with several males and polygynandry, in which both males and females have multiple mates. Detailed observations over several decades have provided a sneak preview into badger life, but the question over their mating system remained to be answered categorically.

We know that badgers can mate throughout the year, but that thanks to delayed implantation (whereby fertilised eggs are not implanted in the uterus until the winter solstice) females only give birth once a year, in late winter or early spring. Unravelling the badger's mating system, however, is problematic given that there can be up to 30 badgers within a group, and cubs are born underground where they remain for their first eight weeks of life. With many potential mothers and fathers in the frame, it's very difficult to determine the parentage of each cub just by watching the group. Furthermore, if we don't know who the parents of a cub are, then we cannot tell how closely other individuals within each social group are related. Fortunately we now have a useful tool at our disposal to help with this. Molecular genetic techniques can be used to establish

badger cubs were born in Wytham Woods, and the social affiliations of 1 081 badgers were recorded. This wealth of information offered a unique opportunity to unravel the mating systems and social organisation operating within the Wytham badger population.

I was lucky to be offered the opportunity to study the Wytham badger data as part of a doctorate, funded by the People's Trust for Endangered Species and supervised by David Macdonald.

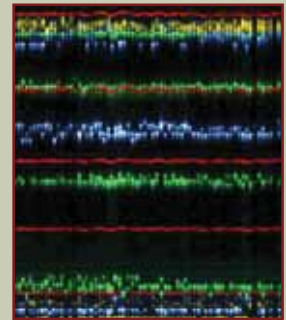
Using only a few hairs from each Wytham badger, I was able to extract enough DNA to 'genetically

The Wytham badgers are closely monitored year round by researchers from WildCRU. Thanks to Hannah's research, the family ties of each individual are now known.

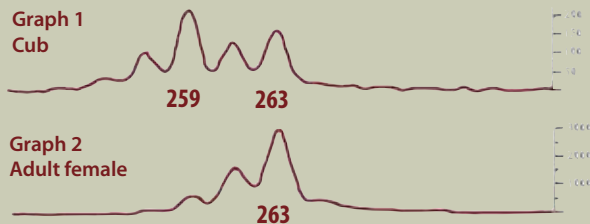
Who's who? Using DNA to unravel family ties

Hannah's genetic fingerprinting work made use of short sequences of DNA known as microsatellites. Each individual animal has two copies, or alleles, of each microsatellite in its genome. By labelling specific sections of microsatellite DNA with a fluorescent dye, it is possible to measure the relative length of the alleles by following the progress of each through a gel. The principle is similar to that of the old fashioned paper chromatography most of us used to separate pigments in the school lab. Longer alleles move more slowly through the gel and appear near the top in the picture (right).

For each microsatellite sequence, a badger cub inherits one allele from its mother and one from its father. The cub represented in graph 1 below had two different alleles of lengths 259 and 263, whereas the adult female in graph 2 only has the one allele, 263 (and therefore has two copies of this). The cub could have inherited its allele 263 from the adult female, thus these two badgers may be mother and offspring. By looking at 22 different microsatellites, Hannah gleaned enough information to identify the mother and father of each badger cub.



Fluorescent gel – the alleles of the microsatellites labelled in colour at the top of the gel are longer than the alleles of the microsatellites at the bottom of the gel.



ANDREW HARRINGTON

■ FEATURE Badgers

fingerprint' them. This required specialist equipment that was provided by the Sheffield Molecular Genetics Facility – a national centre run by Terry Burke and funded by the Natural Environment Research Council. With Terry's help, and that of Lisa Pope (a post-doc at the University of Sheffield) I worked out the genetic fingerprint of each badger, then used the techniques described in the box on p.11 to assign mothers and fathers to 595 of 630 cubs that I studied. This showed that in any given year there

extra-group fathers were more likely to come from neighbouring social groups than groups further away. The results are very similar to those seen in another badger population in Woodchester Park, Gloucestershire, which is of a similarly high density to Wytham Woods.

In Wytham Woods, females had an average litter size of 1.4 cubs. Within a litter it was possible for the different cubs to have different fathers, a phenomenon known as multiple paternity. This happens

“IT IS POSSIBLE FOR THE CUBS IN ONE LITTER TO HAVE DIFFERENT FATHERS. THIS IS KNOWN AS MULTIPLE PATERNITY”

might be up to seven different mothers and seven different fathers within a badger social group, with the mean being 1.9. Interestingly, the fathers were not necessarily from the same social group as the mother, and 50% of cubs had a father that lived in a different social group (see map right). These

as a result of the female badgers' ability to mate throughout the year and delay implantation until December. Rather than be restricted to a short mating season each year, a female can mate many times with different males over an extended period. In effect, multiple paternity allows females to 'hedge their bets'

Badgers are territorial, and all members of the group help stake a claim leaving droppings in conspicuous latrines and making claw marks on the ground, on fallen logs and on tree trunks.

regarding the quality of available mates.

If there is a lack of suitable mates within the social group, a female may look further afield. On some occasions, paternity for a single litter involved one father from the mother's social group and one from a different social group. Overall, both males and females are promiscuous; females may mate with more than one male, and males may also mate with



ANDREW PARKINSON

fact FILE Badger



DAVE BEVAN

Badgers belong to the mammal order Carnivora, and the family Mustelidae. Their closest relatives in British fauna are otters, polecats, stoats and weasels. They are protected by law, but are also under threat of culling in order to limit the spread of bovine TB, which they carry.

COMMON NAMES Badger, brock, *mochyn daear* (Welsh) *an brochlach* (Scots Gaelic), *an broc* (Irish Gaelic)

SCIENTIFIC NAME *Meles meles*

DESCRIPTION Unmistakeable among British mammals. Adult head-body length 67–80 cm, weight 9–12 kg. Head small with tapering snout, marked with two broad black stripes on a white background. Body pelage grizzled grey and shaggy, disguising surprisingly lean, muscular physique. The feet are broad, with five toes each bearing a large sturdy claw.

HABITAT Deciduous woodland, sometimes in large gardens, usually where these abut good worming territory, such as pasture. Setts are built preferentially in well drained, often sandy soils. Undulating terrain offers better opportunities for sett building than flat.

HABITS Nocturnal and crepuscular, burrowing. Lives in territorial groups of up to 30 individuals. Sett is a system of tunnels and chambers, sometimes very extensive. Entrances are usually marked by a heap of excavated sand and discarded bedding (dried grass and other plant matter).

DIET Omnivorous, mainly earthworms and other invertebrates, also eggs and young birds and other vertebrates, plant matter including fruit, tubers, nuts and crops. Only native predator of hedgehogs.

BREEDING May mate in any month, litters of 1–5 young (usually 2 or 3) cubs born January–April (usually February); venture above ground 8 weeks, weaned 3–6 months, sexually mature 2 years, longevity up to 14 years in the wild.

DISTRIBUTION Widespread throughout Ireland and Great Britain, especially so in the southwest.

CONSERVATION STATUS Setts are protected to prevent illegal baiting. British and Irish populations periodically subject to controversial culling to limit the spread of bovine TB.



Young badgers spend their first summer exploring the group territory and mingling with other individuals of all ages. It can be almost impossible to work out who is related to whom using only behavioural observations.

ANDREW PARKINSON

more than one female. In other words, badger mating systems are polygynandrous in high density populations.

Knowing the genetic fingerprint of each badger also allowed me to look in detail at the genetic relationships between all individuals within a social group, and between members of neighbouring social groups. Previous observations suggested that badgers tend to live in the group in which they are born and that only a few of them change

social groups later in life. I therefore expected there to be relatives within social groups. I found that on average group members were slightly less related than half-siblings, but that one third of group members were more likely to be parent-offspring or full siblings than unrelated individuals. Given that 50% of cubs have an extra-group father it makes sense that on average group members are slightly less related than half-siblings but that there are some parent-offspring or full siblings

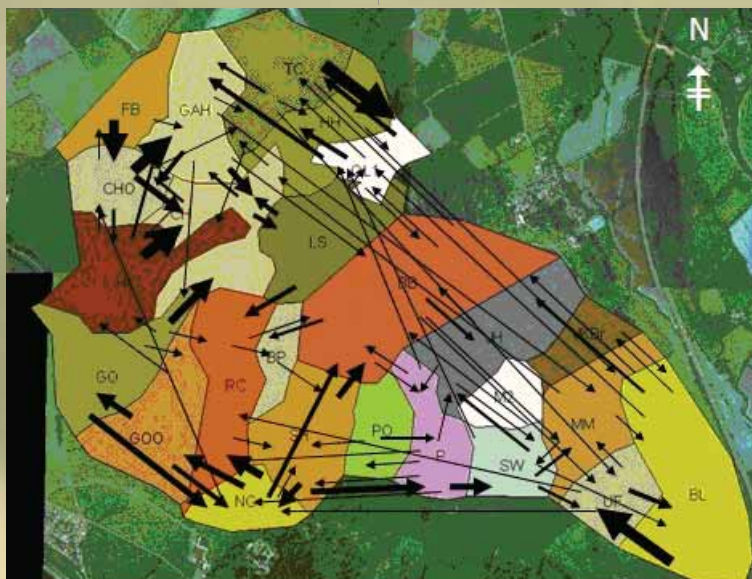
Badgers often spend several minutes together after emerging from the sett, before heading off in different directions to forage independently.



DAVE BEVAN

within a group. This provides the first concrete evidence that badger social groups contain relatives, and that they also tend to have relatives in neighbouring groups.

These results were only made possible by the dedicated long-term support that the PTES has provided for the Wytham badger project. My findings, that badgers have a polygynandrous mating system and that social groups consist of relatives, could not have been achieved without the aid of molecular genetic techniques, and have thus been published in the journal *Molecular Ecology*.



A colour-coded map of the badger social groups in Wytham Woods. Arrows point from the father's social group to cub's group, with the size of the arrow representing the number of paternities.

MORE DETAIL



The research described in this article has been published as follows:

Dugdale, HL *et al*, Polygynandry, extra-group paternity and multiple-paternity litters in European badger (*Meles meles*) social groups. *Molecular Ecology*, 2007, 16(24) pp5294–5306.
 Dugdale, HL *et al*, Reproductive skew and relatedness in social groups of European badgers, *Meles meles*. *Molecular Ecology*, 2008, 17(7) pp1815–1827.